



PRESIDENCY UNIVERSITY

BENGALURU

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End - Term Examinations - December 2025

Date: 19 - 12- 2025

Time: 09:30am - 12:30pm

School: SOCSE	Program: B.Tech		
Course Code: PHY2501	Course Name: Optoelectronics and Quantum Physics		
Semester: I	Max Marks: 100	Weightage: 50%	

CO - Levels	CO1	CO2	CO3	CO4	CO5	CO6
Marks	10	12	20	14	14	30

Instructions:

(i) Read all questions carefully and answer accordingly.

(ii) Do not write anything on the question paper other than roll number.

(iii) Given : Planck's constant $h = 6.625 \times 10^{-34}$ Js; Boltzmann's constant $k_B = 1.38 \times 10^{-23}$ J/K, Speed of light $c = 3 \times 10^8$ m/s, Mass of the electron $m = 9.1 \times 10^{-31}$ kg, Charge of the electron $e = 1.6 \times 10^{-19}$ C

Part A

Answer ALL the Questions. Each question carries 2marks.

10Q x 2M=20M

1.	How a Quantum Computer is different from a normal computer?	2 Marks	L2	CO3
2.	What is de-Broglie's hypothesis?	2 Marks	L2	CO4
3.	Describe the superposition of quantum states?	2 Marks	L2	CO3
4.	Define inner product of two vectors?	2 Marks	L2	CO4
5.	Write down the three Pauli's matrices?	2 Marks	L2	CO2
6.	$A = \frac{1}{2} \begin{bmatrix} 1+i & 1-i \\ 1-i & 1+i \end{bmatrix}$ Show that the matrix A is a unitary matrix?	2 Marks	L2	CO3
7.	Show that the matrix A is Skew Hermitian? $A = \begin{bmatrix} i & 0 & 0 \\ 0 & 0 & i \\ 0 & i & 0 \end{bmatrix}$	2 Marks	L2	CO3
8.	Define Spontaneous emission?	2 Marks	L2	CO5
9.	What is the full form of LASER and mention any two characteristics?	2 Marks	L2	CO5
10.	What is the difference between bits and qubits?	2 Marks	L2	CO3

Part B

Answer the Questions.

Total Marks 80M

11.	a.	Explain in detail X, Y and Z single qubits gates.	10 Marks	L2	C04
	b.	Write the matrix representation of S gate and T gate and Mention their truth tables.	5 Marks	L3	C03
	c.	Explain in detail Hadamard gate. Establish the relation between Pauli's gate (X and Z) and the Hadamard gate?	5 Marks	L3	C03

Or

12.	a.	Explain CNOT and SWAP gates with their symbolic representation, the truth table and the matrix form?	10 Marks	L3	C04
	b.	Mention the applications of quantum computing?	5 Marks	L2	C03
	c.	Explain Taffoli gate with neat diagrams.	5 Marks	L3	C03

13.	a.	What is a Solar cell? Explain in detail principle, construction and working of a solar cell with neat diagram and I-V curve?	10 Marks	L3	C06
	b.	Write the differences between Zener diode and normal p-n junction diode?	5 Marks	L3	C01
	c.	The Hall coefficient of a silicon specimen was found to be $-7.35 \times 10^{-5} \text{ m}^3 \text{ C}^{-1}$ from 100 to 400 K. Calculate the number of charge carriers and determine the nature of the semiconductor?	5 Marks	L3	C01

Or

14.	a.	Explain the formation of p-n junction, analyze in detail the possible changes in the depletion layer when the junction is in forward and reverse biased condition with neat diagrams and the I-V graphs?	10 Marks	L3	C06
	b.	What is the role of cooper pairs in Superconductivity? Explain BCS theory of superconductivity. What will happen to the cooper pairs when the temperature is rises above the critical temperature?	5 Marks	L3	C01
	c.	A superconducting tin has a critical temperature of 3.7 K at zero magnetic field and a critical field of 0.0306 Tesla at 0 K. Find the critical field at 2 K.	5 Marks	L3	C01

15.	a.	$ \psi\rangle = \begin{pmatrix} -3i \\ 2+i \\ 4 \end{pmatrix}, \quad \phi\rangle = \begin{pmatrix} 2 \\ -i \\ 2-3i \end{pmatrix}.$ <p>(a) Find the bra $\langle\phi$.</p> <p>(b) Evaluate the scalar product $\langle\phi \psi\rangle$.</p> <p>(c) Examine why the products $\psi\rangle \phi\rangle$ and $\langle\phi \langle\psi$ do not make sense.</p>	10 Marks	L3	C06
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	b.	Write the properties of Pauli's matrices.	5 Marks	L2	C02
	c.	Let two vectors be defined by $ A\rangle = \begin{pmatrix} 2 \\ -7i \\ 1 \end{pmatrix}, B\rangle = \begin{pmatrix} 1+3i \\ 4 \\ 8 \end{pmatrix}$ Find the norm of each vector.	5 Marks	L3	C02
Or					
16.	a.	Two vectors in a three-dimensional complex vector space are defined by: $ A\rangle = \begin{pmatrix} 2 \\ -7i \\ 1 \end{pmatrix}, B\rangle = \begin{pmatrix} 1+3i \\ 4 \\ 8 \end{pmatrix}$ Let $a = 6 + 5i$ (a) Compute $a A\rangle, a B\rangle$, and $a(A\rangle + B\rangle)$. Show that $a(A\rangle + B\rangle) = a A\rangle + a B\rangle$. (b) Find the inner products $\langle A B\rangle, \langle B A\rangle$.	10 Marks	L3	C06
	b.	Explain the properties of wavefunction?	5 Marks	L2	C02
	c.	Show that the vectors $ \psi\rangle = \begin{pmatrix} \frac{1}{\sqrt{2}} \\ \frac{1}{\sqrt{2}} \end{pmatrix}, \phi\rangle = \begin{pmatrix} \frac{1}{\sqrt{2}} \\ -\frac{1}{\sqrt{2}} \end{pmatrix}$ are orthogonal. Is $ \psi\rangle$ normalized?	5 Marks	L3	C02
17.	a.	Derive the relation between Einstein coefficients A21, B12 , and B21 under thermal equilibrium.	10 Marks	L3	C05
	b.	The ratio of population of two energy levels is 1.059×10^{-30} . Find the wavelength of light emitted at 330K.	5 Marks	L3	C06
	c.	Find the population of the two states in an diode Laser that produces a light of wavelength 6500 \AA at 30°C .	5 Marks	L3	C06
Or					
18.	a.	With neat diagrams, explain the different types of radiation-matter interactions. How does stimulated emission contribute to the amplification of light in a laser medium?	10 Marks	L3	C05
	b.	Analyze the essential conditions required for laser action using the concept of radiation-matter interaction.	5 Marks	L3	C06
	c.	Analyze the unique characteristics of laser light and compare them with those of conventional (ordinary) light sources. Explain each property in detail.	5 Marks	L3	C06